Seeing a service in 3D – Implementing a 3D printing service in the University of Queensland Library

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Abstract: The University of Queensland Library, like all libraries, is evolving. As part of this evolution the Library is always looking for new opportunities to expand its services and diversify. Just such an opportunity was realised in the form of a 3D printing service to be made available to all Library patrons. A project to investigate and implement a service to encourage participatory learning, cross-disciplinary collaboration and potentially promote community engagement was initiated in 2013.

3D printers were not new to the University campus with this facility being available but with restricted access. By locating a 3D printer in the Library, all staff and students of the University had the chance to avail themselves of this emerging technology. It was just another example in libraries, of technology shaping services for patrons and presenting new dimensions for Library staff members. Investigations found that some public libraries had taken up this service, yet few, if any, university libraries had yet to do so, often leaving it to independent printing services.

The project team evaluated 3D services already in place and how these might need to be modified, adapted and added to for the academic library environment. Decisions were made, equipment was purchased and the implementation process began in earnest.

Library staff were introduced to the technology via in-house information sessions. They were encouraged to up-skill and expand their roles through training and hands-on operation and to share their experiences and knowledge. Recommendations from the project included: purchase of complementary peripheral equipment, induction workshops and a cabinet for public display of the printer. The service is finding its place and early indications would suggest the time and effort to implement this service was certainly worth it.

Please join us on our journey…

Libraries are interesting places, our patrons know that! But like many businesses, we need to keep our patron's interest by listening to them, interpreting their needs and introducing new products and services - engaging them. Library staff also need to be engaged, to keep abreast of new technologies and evolve. The introduction of services such as 3D printing presents them with an opportunity to gain hands-on experience and increase their skill set. With this in mind, a project request for the "Implementation of a 3D Printing Service" was submitted to the University of Queensland (UQ) Library Executive in late 2013. It was accepted and a project team convened. The team consisted of representatives from all levels of the library including Librarians, Library Technicians and staff from the Library's IT services section. The goal of the team was to investigate the requirements for implementing a 3D printing service in the UQ Library, evaluate if a need existed and, if so, make it a reality.

3D printers were already in use on the UQ St Lucia campus, so why did the Library need to provide this service? Access to existing printers was restricted to staff and students associated with the individual faculties and schools which housed them. By offering this service, the Library would be expanding its services and introducing patrons to an up-to-the-minute technology. The University of Queensland is a community and the Library is a communal space within it. With services such as 3D printing we are providing for our community. We might also see this service as a supermarket sees a loss leader. With a plethora of electronic resources on offer to our patrons the need to physically come into the Library is diminishing, 3D printing may just have the appeal needed to encourage patrons to revisit the library and see what else is physically on offer. With so much 'e' in the library world nowadays it could be nice to introduce a physical rather than virtual service for a change. We are also opening up new avenues to those who may not normally be exposed to this sort of technology; equity and engagement for all.

The team began by identifying who already had printers and services in place. It was found whilst some public libraries had taken up this service few, if any, university libraries had yet to do so, often leaving it to independent printing services. The team contacted three of the providers to arrange visits. Two were public libraries and the third was a printing service within a University. The road trips that ensued were both informative and team building with the exchanging of knowledge and ideas both on the road and at the destinations.

Experience and hindsight are wonderful tools to have in your toolbox and although we had yet to experience life with a 3D printer these providers had done so and were most giving of their time and knowledge. The stand out point we learned was – ONE MACHINE IS NOT ENOUGH. Due to the mechanical and technological nature of the process, failures do happen

and machinery goes offline. To be able to provide a continuous service, a second printer was required and requisitioning another unit became the team's first recommendation. We also learned that trying to increase efficiency by printing multiple jobs at once can be fraught with danger, as a malfunction not only sees one project ruined but several. This forewarned us of the time component involved in this service.

To broaden the scope of our investigations a search was made, via the Internet, to collate information on various aspects of 3D printing services being provided by university libraries (most of which were located in the USA). It was found that the method of submission for the request varied and included, online forms, email attachments, printable forms and in person. Costing of the service was per cubic inch, per gram and per hour or part thereof. Most Libraries had a consistent price per hour/gram/cubic inch however some libraries had a base cost/setup fee plus another lesser charge per subsequent hour/gram/cubic inch.

Payment methods were upfront at time of lodging the request or after the request had been appraised and a cost assigned. Payment upon pickup of requested item was also an option offered by some libraries (failure to pick-up an item saw one Library add the charge to the patron's library fines). Payment options included: via credit card, cash, debit card or some in-house print and ID cards. Some Libraries charged extra for extended consultations and repairing the digital files of the 3D models. The majority of institutions disposed of items that were not collected within 2 weeks.

Conditions of Use were fairly standard across the board with items needing to be from a Creative Commons site (e.g. Thingiverse.com), self-designed or copyright free. The responsibility of cleaning up the printed model was always with the patron. At all times providers reserved the right to refuse a request if, among other things, they thought the item was unsafe, harmful, dangerous and/or posed an immediate threat to the well-being of others or was deemed obscene and/or inappropriate.

Most libraries regulate the machine and its output. Jobs are submitted to Library staff that queue the jobs for printing. It was found that turnaround time was influenced by workload, file size, colour required, errors and rectification of it within submitted files. Some libraries provide training/workshops and after attending these workshops patrons are allowed to set up, send and print requests by themselves. In some cases, Makerspaces/Media Labs were areas that housed the printers and some had swipe card access for after-hours entry and for statistical purposes. Makerbot's Replicator 2 and 5th Generation printers were among the most popular machines. ProJet, Up! Plus 3D and uPrint SE plus all had a very small representation.

The project team discussed the findings, determined there was a need for the service, that it could be incorporated into exiting library operations and so, a recommendation was made to the Library Executive. The next phase was to select a printer that would be suitable for library staff to learn on and then become the start of our 3D printing fleet if the Library Executive approved the service. The key selection criteria for the printer were defined by lessons learned from other libraries in the earlier consultations. The selection criteria were:

Cost, not only did the initial purchase price of the machine need to be within our budget but also the ongoing costs had to be considered. The printer's consumables were covered by charges passed on to the customer, if they were too high then patrons may not embrace the service.

Reliability, the technology is still relatively new and we learnt that the printing process is susceptible to imperfections and failures. We wanted maximum uptime for this new service. If something failed on the printer we could quickly develop a backlog of orders that can be hard to catch up on.

Ease of use, we wanted anyone working at the library to be able to operate this equipment. As with most libraries, staff will have numerous duties competing for their time and attention. Getting them up to speed and operating the printer quickly and easily would be a great benefit. Therefore the printer needed to be relatively easy to use and troubleshoot. This technology is still far from "set and forget". Regular user attention is required for calibration, refreshing consumables and troubleshooting mechanical faults.

Support, with the likelihood of mechanical and technological problems quite high, we planned to purchase the printer from a local distributor offering good aftermarket support. Money could be saved by purchasing from any of the many international sellers on the Internet, but this could also introduce unreliable international shipping times, import taxes and non-compliance with Australian Standards.

We decided the printer that suited our requirements was Makerbot's Replicator 5th Generation model. An outline of our findings plus a purchase proposal was accepted by the Library Executive and an order was placed for the machine.

When it came to deciding on a pricing model, we initially adopted a similar one used by other libraries. A processing fee ($5.00) would cover the preparation of the file including: error checking, scaling and previewing. We would then add the cost of the material used in the model, measured by weight (approximately 10 cents per gram). However, the weight of the

model could only be confirmed once the file had been through the preparation process in the 3D printer's software. This meant that a quote would then have to be provided to the client for approval before going ahead with the job. This method slowed the process a great deal. As the small cost of material used for these models was relatively insignificant to the processing fee, it was decided to abandon the weight cost and just charge a flat fee for each print job. This simplified the payment process for everyone involved and improved the throughput of print jobs.

Our order submission method started as a simple process where patrons delivered their digital file on a memory stick with a paper form detailing the parameters required for their print job. We soon found that this introduced opportunities for mix-ups and lost orders. We had to evolve the service early on and pushed for the move to an online submission method that was implemented successfully. We now have a form on our library web page for patrons to upload their digital files and printing requirements.

The library staff managing the printing service work on a rotating roster. This meant that the staff member who starts to process an order may not see it through to the end and will need to hand over to another staff member to finish off the final stages. There are many steps to the process so an order tracking system was implemented to help reduce confusion. A simple table and checklist was set up on our intranet to follow the progress of the order as it moved through each stage. Therefore anyone on the team can take over and keep the orders progressing smoothly.

Once we had taken delivery of our new 3D printer it was time to figure it out and share the knowledge with library staff operating the service and anyone else who was interested in the technology. As soon as the box arrived there was an atmosphere of excitement in the library. We had our first order enquiry, before it was even out of the box, from a medical student who had heard the library was getting a 3D printer.

The team leader from the library's I.T. support department was given the responsibility of testing the unit and collating some training material for other library staff. We were going to need more than the user manual to train everyone, although it was a good start. Combinations of resources were employed, including a cheat sheet highlighting key functions and video training courses on Lynda.com. This gave staff a variety of learning methods to choose from. One of the best training tools was a live demonstration of the printer. This gave the trainee a chance to get their hands on the equipment and 'have a go'. It also seemed to prompt some good questions about how the printer worked and how we can get the most from it for our service. The training process was continually refined as we went along and we developed a

checklist of minimum requirements to be completed by all staff. This helped to maintain a consistent base of knowledge for staff running the service. By the end of the training process our staff possessed the skills to:

- Understand the working parts of the machine including the health and safety concerns (i.e. heat and moving parts).
- Prepare a model for printing and load or unload the printing material (PLA plastic).
- Find 3D models online and prepare them for printing.
- Adjust the size, resolution and position of the model for best results.
- Troubleshoot failures - Was it the model? Was it the machine? Was it the user?
- Complete the model with a post print clean up - even though this was going to be the responsibility of the customer, we would still need to guide them on the process.

Each team member's knowledge developed with the hours they spent on the printer. We encouraged everyone to share their experiences and contribute to an online troubleshooting guide. Common problems were detailed with the possible cause and solution for future reference.

Purchasing a 3D printer for UQ Library wasn't just going to kick-start our printing service it was an opportunity to introduce the technology to all library staff. We prepared in-house information sessions, available to all UQ library staff to find out what it was all about and see it in action. The first two sessions were booked out and an additional session was scheduled for those who had missed out. Attendees were introduced to 3D printing technology with examples of printing techniques and how it has been incorporated into various industries. We discussed prototyping by engineers and architects as well as creating actual prosthetics for the medical field. The mechanics of how models are produced were explained in not too technical terms, we wanted to cater to library staff from various levels of technical experience. Our new machine's capabilities were shown off with a live demonstration and numerous example models were passed around the room. The session gave library staff the opportunity to ask questions and discuss 3D printing amongst their peers. There were some great questions from attendees on how it was going to work as a service for library patrons. These questions made us think about the planned service and consider how it may need to evolve with the needs of the customer and library staff delivering it.
Attendees were given the opportunity to submit an order for a 3D object to be printed free of charge. We directed them to Thingiverse.com to find a model, choose a colour and send us

the order. Not only did this encourage staff to get involved with the technology, it also gave us a chance to trial the proposed printing service. We were able to iron out a few workflow bugs before we went live to the university community. The expression of interest from library staff was very successful, we received and completed 88 orders and the feedback was overwhelmingly positive. Our 3D printing service has been processing orders successfully for over six months now and as its popularity grows, so do the skills and knowledge of our library staff.

While reflecting on the journey we had taken, the investigations made and the eventual implementation of the service, a few questions came to mind. **Was it worth it?** The answer was a resounding yes. Training for staff, directly involved in the service, broadened their knowledge and skill sets. They also got to participate in and experience a service start-up from concept to implementation. The staff not directly involved, benefitted from information sessions that provided an introduction to this new technology. Patrons gained access to a new and exciting service with a steady flow of requests being submitted. These submissions are now moving beyond the novel to more assignment-oriented requests. Positive feedback from our patrons and staff have supported the library's move to this service as has the numerous reports and items being telecast or published about the impacts of 3D printing in everyday life. **Can it be sustained?** Yes. With the ongoing need for easy access to this type of technology by our patrons, we are confident that interest/demand will remain into the future. **What are the areas for growth and project recommendations?** The team quickly became aware during their investigations that peripheral equipment such as 3D scanners and 3D pens would be useful in growing the service. Consideration will also need to be given to purchasing printers that produce models in different materials. **The future?** With extra equipment coming on board, the future could see a Makerspace being created and workshops being convened for patrons wishing to become self-sufficient/DIY in their creation of 3D printed objects. Whatever the future holds you can safely bet it will involve technology and staff with the skills to use it will be required.